A Model for LACCEI: Minority Serving Institutions and CyberInfrastructure Research/ Education, Minority Serving Institutions-CyberInfrastructure Empowerment Coalition (MSI-CIEC)

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ABSTRACT

Institutions within the Latin American and Caribbean Consortium of Engineering Institutions lack sufficient resources and knowledge to take significant advantage of national and international computational resources available to advance computational science research and education. Such institutions, just like the USA's Minority Serving Institutions (MSIs), can provide a critical yet untapped human resource potential. The US National Science Foundation's TeraGrid has attempted to define, promote and deliver an integrated set of high performance computing resources to the US academic research community. However, a gap persists in the connections between the TeraGrid program and non-TeraGrid national computational resources and data. For MSIs and other users, these circumstances hinder seamless, natural use of resources from local, campus infrastructure through national and international high performance computing research tools. In spite of impressive TeraGrid advances, its user community falls short of engaging a much broader potential community such as the MSI community. This paper promotes a campus-based integrated CyberInfrastructure (CI) to bridge this gap. Such can provide new dimensions to an institution's contributions to its national commitments especially in areas such as human and economic development and security.

Keywords: CyberInfrastructure, Minority Serving Institutions, Visualization, LACCEI;Grid Computing, security

1. INTRODUCTION

Institutions within the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI, www.laccei.org) lack sufficient resources and knowledge to take significant advantage of national and international computational resources available to advance computational science research and education. Such institutions, just like the USA's Minority Serving Institutions (MSIs), can provide a critical yet untapped human resource potential. With the US MSI designated universities, the US National Science Foundation's[2] CI-TEAM[3] Minority Serving Institutions CyberInfrastructure Empowerment Coalition (**MSI-CIEC**) conducts assessments of the CyberInfrastructure (CI) capabilities relative to furthering research and education at these universities. In tandem with the campus wide assessment, **MSI-CIEC** provides a CI awareness and engagement workshop for faculty, administrators and students referred to as CI Day. **MSI-CIEC'**s organizational structure and strategic planning activities provide organizations and institutions (such as TeraGrid, NSF, US Department of Homeland Security (HS) and others), significant opportunities to engage with MSIs and their talented minority student populations and faculty.

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[2] National Science Foundation, Office of Cyber Infrastructure, OCI 063652

[3] CyberInfrastructure –Training, Education, Advancement and Mentoring

A recent "All Hands" meeting at the San Diego Supercomputer Center of institutions within the current MSI-CIEC portfolio provided opportunity for the 'users' to assist in helping to set MSI-CIEC's next set of objectives. This paper discusses the comprehensive nature and scope of these activities, citing examples of increased computational science and visualization activities at the engaged MSIs within this portfolio. MSI-CIEC's development and concepts are followed by descriptions of its ***Institutional Capacity Building for CI*** (CI campus assessments etc) and ***Building the CI-enabled MSI Research Capability.*** A **Summary** of MSI-CIEC accomplishments ends the paper.

Many lessons are to be learned from the AH Meeting for engagement of MSIs. Much can be gleaned for our LACCEI colleagues. Notable are the increased capabilities these activities generate for MSIs to engage in CI research, curriculum and education advancement. Such undertakings, for example, provide capability for LACCEI institutions and MSIs to engage more efficiently in e-science- a new approach based on computer simulation / visualization and rapidly being adapted as one of the most successful modern methods for experimental scientific discovery. Another example lies in the efficiency and low cost of Cloud Computing (programs and services delivered over the internet) which is changing the way we use computers and related resources and for which CI software applications become a facilitative technology. In all areas Security issues abound and become especially significant for national security efforts where engaging LACCEI institutions and MSIs can enhance this workforce.

1.1 CYBERINFRASTRUCTURE DEFINED:

The National Science Foundation's (NSF) 2003 report of the Blue Ribbon Panel on CyberInfrastructure, Revolutionizing Science and Engineering through CyberInfrastructure, or the Atkins Report, coined the term "CyberInfrastructure" as they reviewed the recent radical advancements in science and engineering that have an IT basis. The report put the term in context as follows:

"The term infrastructure has been used since the 1920s to refer collectively to the roads, power grids, telephone systems, bridges, rail lines, and similar public works that are required for an industrial economy to function…. The newer term 'CyberInfrastructure' refers to infrastructure based upon distributed computer, information, and communication technology. If infrastructure is required for an industrial economy, then we could say that CyberInfrastructure is required for a knowledge economy. (p. 1.2)"[41]

More recently, the newly formed NSF Office of CyberInfrastructure developed a strategic plan for CI and defined CI below as:

"The comprehensive infrastructure needed to capitalize on dramatic advances in information technology has been termed CyberInfrastructure (CI). CyberInfrastructure integrates hardware for computing, data and networks, digitally-enabled sensors, observatories and experimental facilities, and an interoperable suite of software and middleware services and tools. Investments in interdisciplinary teams and CyberInfrastructure professionals with expertise in algorithm development, system operations, and applications development are also essential to exploit the full power of CyberInfrastructure to create, disseminate, and preserve scientific data, information and knowledge (p. 6)."[5]

The Atkins report briefly reviews the impact of CI on the sciences and its capability for broadening the participation of institutions mentioning minority-serving institutions (MSIs) specifically and serves as a beneficial reference. The report may be found at http://www.nsf.gov/cise/sci/reports/atkins.pdf. The CI strategic plan,

[1] Atkins, Daniel, E., Kelvin K. Droegemeier, Stuart I. Feldman, Hector Garcia-Molina, Michael L. Klein, David G. Messerschmitt, Paul Messina, Jeremiah P. Ostriker, Margaret H. Wright, *Revolutionizing Science and Engineering Through CyberInfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on CyberInfrastructure*, National Science Foundation, January 2003.

[5] National Science Foundation CyberInfrastructure Council:. *CyberInfrastructure Vision for 21st Century Discovery*. National Science Foundation, March 2007.

"*CyberInfrastructure Vision for 21st Century Discovery*," is also an excellent reference for understanding the general notion of CI. There have been numerous other reports on CI as it applies to a variety of sciences, including the social sciences and the humanities. A compendium of such reports may be found at http://www.nsf.gov/od/oci/reports.jsp.

CI is more than just connecting people via advanced networks and sophisticated applications; CI is about engaging participants in the generation of knowledge. It is about creating opportunities for participants to share expertise, tools, and facilities in powerful ways that have the potential to significantly advance discovery. An essential enabler of this vision is an ability to coordinate the use of public sector information technology across scales, from desktop to TeraGrid. MSI-CIEC strives to create and implement a model for that coordination, building a seamless application development and deployment, technical support, training, and personal communications bridge from desktop to TeraGrid.

1.2 MINORITY SERVING INSTITUTIONS- CYBERINFRASTRUCTURE EMPOWERMENT COALITION:

MSI-CIEC provides a broad systemic approach to reaching underrepresented minority students and engaging this nation's American Indian Tribal Colleges (TCU) and Universities, Hispanic-Serving Institutions (HSIs), and Historically and Predominantly Black Institutions in the exploration, dissemination and adoption of CI tools, services and initiatives supporting research and education. The three organizations (AIHEC- American Indian Higher Education Consortium; HACU- Hispanic Association of Colleges and Universities; and NAFEO- National Association for Equal Opportunity in Higher Education) leading this project represent the broadest coalition of MSIs in American higher education. These organizations are represented in MSI-CIEC by their Technology Directors respectively: Al Kuslikis, Alex Ramirez and Karl Barnes. They are joined by Diane Baxter of San Diego Supercomputer Center, Geoffrey Fox of Pervasive Technology Institute, Indiana and Richard A, Aló, Center for Computational Science at University of Houston Downtown.

Engaging MSIs is an efficient way of reaching the growing number of underrepresented minority college students, the next generation of scientists and engineers. Although only a relatively small percentage of colleges and universities in the country, MSIs serve a much greater proportion of underrepresented minority students, (e.g., HSIs are about 6% of US higher education institutions, but produce 33%, of Hispanic science baccalaureates while HBCUs produce the same percentage for African Americans) [NSB04]. AIHEC and HACU are the only national associations representing TCUs and HSIs, respectively while NAFEO has served as an advocate for historically and predominantly black colleges and universities since 1969. MSI-CIEC is able to attract notable national computing experts to plan, design and implement effective practices that broaden participation and impact on society and the next generation of scientists and engineers.

MSI-CIEC has been established as a virtual organization to accelerate the development of a CI-related STEM (Science, Technology, Engineering, and Mathematics) workforce with the following:

Vision: To advance STEM and participation of US traditionally underrepresented minorities in STEM and in the global STEM workforce, particularly e-science, through MSIs and the emerging CI.

Mission: To build/ enhance the social and technological mechanisms for meaningful engagement of MSIs in CI.

MSI-CIEC's efforts are to develop the CI "middleware" resources to encourage, broker, enable and manage meaningful CI initiatives involving MSI collaborations for the use, support, deployment, development, and design of CI to enable the advancement of e-science research and education. We promote the development of the nation's diverse STEM workforce, including the current and next generation of the STEM professoriate in an increasingly diverse society. The project establishes a dynamic community of learning and practice, a CI-enabled distributed

research and education network providing e-science education and research opportunities to MSI faculty and students. It exploits the synergies between CI for science and engineering and the environments supporting electronic business and communities, enabling MSIs as both national research institutions and as regional economic development hubs. This was immediately recognized by the US Department of Homeland Security as a much needed resource for the development of future workforce and for expanding its research base.

Motivation for MSI-CIEC: The NSF report, Women, Minorities, and Persons with Disabilities in Science and Engineering [NS07], states that minorities will comprise more than half (52%) of the resident college-age (18–24 years old) population of the United States by 2050. Between 2002 - 2007, computer science departments across the country have shown large declines in enrollment [V07a]. Yet, our traditionally underrepresented minorities constitute about 1% of doctoral engineers in 2005-2006. The small number of minority faculty, combined with need for minority role models and mentors, perpetuates a troublesome cycle of underrepresentation in science, technology, engineering, and math (STEM) fields. With globalization and the increasing competitiveness of other countries in STEM, the United States is in danger of losing its leadership in these areas [CS07] unless it mobilizes its efforts to broaden participation. Efforts such as The White House's American Competitiveness Initiative [WH06] and the report by the President's Council of Advisors on Science and Technology [PC07] further support the need to invest in development of our youth to ensure our country's leadership in STEM areas as well as the economic growth of our country. *MSI-CIEC believes MSIs can contribute significantly to initiatives on competitiveness through the education and development of minority students that excels and advances them in computing.*

Using the "National CyberInfrastructure" (Open Science Grid, TeraGrid, Internet2, National LambdaRail, and other federally-funded CI technologies) this project explored needs, processes, dependencies, critical pathways, and potential immediate outcomes for providing Minority Serving Institutions with full and complete access to critical research and education resources. MSI-CIEC highlights the following CI concepts and objectives.

Key Project Concepts

1. CI is critical to all involved in Research and Education
2. CI is intrinsically democratic, supporting broad participation
3. MSI's should lead MSI integration with CI
4. Use CI experts to guide projects at MSIs
5. Aim at scalable (systemic) approaches
6. Goal is peer collaborations and mentoring of MSI faculty in CI leading to their long range involvement
7. Collaboration, coordination, and trust-building should be across institutional, cultural, and geographical barriers
8. Activities should be professionally evaluated

Key Project Objectives

1. Mobilize faculty and student communities to use CI in their research and teaching, focusing first on a few key early adopter Minority Serving Institutions, and developing an approach that has the potential to eventually reach the over 330 in AIHEC HACU and NAFEO
2. Provide access pathways to physical infrastructure necessary for participation in CI
3. Support curriculum development, research, mentoring, and teaching teams
4. Exploit local, regional, national, and global CI(Grid) resources appropriate for the goals of the institution
5. Develop a prototype portal for supporting broad participation in CI with low barrier to entry
6. Integrate assessment metrics as formative evaluation for development of an approach for connecting MSI's to the national research and education CyberInfrastructure

MSI-CIEC has built upon the successes of its MSI CI Institute (MSI-CI^2) pilot project (NSF CI-TEAM Demonstration Project), and the earlier Advanced Networking with Minority Serving Institutions (AN-MSI) project (NSF project #9980537) by strengthening and expanding a distributed community of researchers, faculty,

and students who participate collaboratively to provide CI executive awareness, training and support, pilot new CI tools that support the distributed research and education process, and plan and implement specific research and education projects. This virtual organization of MSIs and CI stakeholders leverages resources from across the MSI and CI communities, providing the foundation for CI-enabled MSI research programs that are prepared to provide a major contribution to the national research agenda. This resulted also in an internationally recognized

Advisory Team

1. Malcolm Atkinson, NeSC (National e-Science Center, Edinburgh UK), ICEAGE (International Collaboration to Extend and Advance Grid Education EU)
2. Fran Berman, initially University of California San Diego, San Diego Supercomputer Center; now Rensselaer Polytechnic Institute
3. Jay Boisseau, Texas Advanced Computation Center
4. Charles Catlett, TeraGrid
5. Kelvin Droegemeier, Oklahoma, LEAD (Linked Environment for Atmospheric Discovery)
6. Tom Dunning, National Center for Supercomputer Applications
7. Mark Ellisman, SDSC, BIRN (Biomedical Informatics Research Network)
8. Ian Foster, Chicago, Open Science Grid Globus etc
9. Juan Meza, LBNL (Livermore Berkeley National Laboratory)
10. Dan Reed, UNC, Renaissance Computing
11. Richard Tapia, Rice University
12. Larry Smarr, University of California San Diego, California Institute for Telecommunications and Information Technology, Cal(IT)2

2. INSTITUTIONAL CAPACITY BUILDING FOR CI

To support MSI-CIEC institutions in their adoption of CI as an institutional development strategy, MSI-CIEC supports institutional capacity building through campus assessment and technical assistance visits. Services provided are intended to help participating MSIs progress toward acquiring and maintaining the hardware and connectivity needed for a significant level of CI engagement, as well as possibly becoming CI resource providers, such as local or regional computing, data storage, application, tools and other CI resources. The **CI Access Empowerment Team** is coordinated by co PIs,

2.1 MSI CI SURVEY:

MSI-CIEC develops a brief CI capacity and use survey that MSIs are asked to complete online. There are both institutional and faculty components. The survey results provide an overview of the current infrastructure and campus plans relative to the emergent CI and related science domains at MSIs, as well as, information to support portal and professional development training design and to populate the social network collaboration directory. A summary of the information gathered is disseminated to institutions, federal agencies, and industry partners

2.2 CAMPUS TECHNICAL ASSISTANCE VISITS:

To assess the current state of computing and IT at participating MSIs and to identify specific gaps or CI campus needs, MSI-CIEC provides technical assistance campus visits MSI-CIEC tailored to match the specific computing and networking development plans and needs of selected MSIs. Site visit teams include one or more experts (faculty, staff, administrator or consultants) with specific expertise in computing and networking infrastructure, applications, CI research, CI education, or strategic planning. The site visit teams provide administrators, faculty, and staff information about CI-enabled opportunities for strengthening STEM research and education programs.

They facilitate CI-focused strategic planning by the college community. The site visit team provides on-site and written recommendations on strategies for improvement, reference material, and ongoing assistance, as needed. All materials and information, including information on new computing and networking infrastructures, technologies, and their applications, are made available for other campuses to utilize through the project portal and linked to the AIHEC, HACU and NAFEO web sites.

2.3 CI TECHNICAL ASSISTANCE

helps participating MSIs strengthen their capacity to build and manage CI-enabled collaborative environments and services, and more effective technology utilization to deliver and manage services, information, and resources to community members using open-source tools and services. It provides technical recommendations and support in the acquisition and maintenance by MSIs of the infrastructure necessary to both access and contribute to the national CI, e.g. clusters, AG nodes, and connectivity costs. MSIs are assisted in identifying opportunities to contribute computational, data and other services and resources to the national grid, and possible funding models and opportunities. MSI-CIEC accesses its partnership's resources to support MSI IT staff in establishing and maintaining clusters, Science Gateways, parallelization and code performance, SRB and the Access Grid.

2.4 PARTICIPATING MSIS

Participating MSIs are selected to participate in the project based upon an initial survey review of the MSI capabilities and needs, and where we can have the most strategic impact on CI and on demonstrating the potential of CI to MSIs and a clear model for other MSIs to follow. **Two exemplars are Navajo Technical College and Elizabeth City State University Projects as described here**.

Navajo Technical College: Internet to the Hogan Project (Inauguration at Navajo Tech shown in photo below) is a High Performance Networking; Cluster/Grid Computing Project focused on the Navajo Nation and the College. It is a result of our first CI Day activity and is a **Collaboration of MSI CIEC and our Partners including:** San Diego Supercomputer Center; TeraGrid; National Center for Supercomputer Applications; University of New Mexico; SDSC High Performance Wireless Research and Education Network connecting to the National Lambda Rail and Internet 2 at OC3 speeds. As a result NTC is expanding degree offerings through PhD and curriculum activities for Navajo K-12.

As one of the MSI-CIEC model institutions for engagement in CyberInfrastructure, discussions and planning have commenced with Navajo Technical College to develop Web 2.0 curriculum to assist with the recruitment and retention of MSI students into CI related computer science as a major.

- Web 2.0 applications have gained in popularity among young students.
- Web 2.0 has some potential for application within CI particularly social collaborations, virtual organizations and possibly even scientific applications, such as a more user friendly interface to TeraGrid or science gateways. It may aid in the development of CI applications or interfaces for the Navajo nation's computing grid currently under development.
- The same is true for the Elizabeth City State University computer grid and high performance network described below.

Elizabeth City State University was site of the second CI Day event held on January 3-4, 2008 at Elizabeth City State University (ECSU), a 3000-student Historically Black University in Elizabeth City, North Carolina, that receives its high-speed internet connection to the Grid through the North Carolina Research Engineering Network (NCREN). The goals of 'CIDays at ECSU' were (1) provide faculty, staff, and administrators there with information about CI developments in education and research, (2) create networking opportunities with national CI organizations and experts, and (3) provide breakout sessions for faculty within each of the university's four colleges to brainstorm how CI might be used in ECSU classrooms and labs. Most of the university's top

administrators were present, including the provost, the deans from each of the university's four schools, and the Chief Information Officer. A total of 90 ECSU faculty, staff, and administrators registered and provided email addresses at the Friday session.

In order to measure the initial impact of the event and solicit feedback on how future CI Days could be improved, these 90 individuals were emailed an online evaluation survey in the weeks that followed. The survey was supposed to go out the evening of January 4th, but due to some miscommunication with event planners and other delays, it was not sent out by the provost's office until January 24th. The recipients were given one week to complete the survey, and 31 did so, for a response rate of 34%. Due to the 3-week delay in the survey's delivery and the relatively low response rate, the survey results reported here should not be considered a representative and definitive sample of attendee's opinions about the event, but they do give a good sense of the general response to the event, what sessions were particularly useful, and what attendees hope to do with regards to CI in the future. Resulting from this activity and its evaluation the following project evolved:

Polar Grid CI through Polar Grid Science Gateway (graphic above)

- Collaboration of
    - MSI CIEC
    - NSF Center for Remote Sensing of Ice Sheets (CReSIS) Kansas
    - Links TeraGrid with CReSIS
- ECSU and Indiana University now creating CI linking intermittently disconnected field and base grids in polar regions to 'lower 48' data and computing resources
    - Significant Hardware/ Software challenges advancing CI research enabling new science discoveries
- Adding CI track in Masters program and CI Internships

Elizabeth City State University PolarGrid Science Gateway

3. BUILDING THE CI-ENABLED MSI RESEARCH CAPABILITY

The main strategy for engaging MSIs into CI research involves bringing MSI faculty into the growing CI-supported research community. MSI-CIEC provides a brokering function between individual CI researchers, national and international e-science programs, their researchers and faculty, and MSI faculty, identifying opportunities for MSI faculty and students to collaborate on research projects as research fellows or interns, research personnel, or co-PIs. The **CI Research Empowerment Team** is coordinated by co-PI.

3.1 RESEARCH SUPPORT FOR MSI FACULTY AND STUDENTS:

MSI-CIEC facilitates research collaborations by:

- Residential training at SDSC and Argonne National Lab
- building an online social network site with a research collaboration directory where majority and minority CI researchers and MSI faculty/ graduate students can present personal background and contact information, research interests, including keywords for classification and keyword searches, current and past research projects, presentations/ publications, desires for specific or general research collaboration, discussions/ idea exchange, or professional development, current/ past collaborators with links to their information, favourite research related sites and other personal web sites, and facilitating others to join and build the social network;
- visiting faculty/student exchange and research symposia;
- collaborative proposal development and identifying fellowships, internships and other research opportunities for faculty and graduate/undergraduate students, leveraging NSF programs such as Research

Experiences for Undergraduates (REUs), at universities/colleges, (including MSIs), major e-Science research centers, national labs, and CI resource sites (SDSC, NCSA, etc.)

3.2 CI-MEDIATED RESEARCH TRAINING:

A component of the MSI CI survey is completed by faculty who are asked to identify their research and collaboration interests. The responses are used to help connect potential research collaborators based on similar interests and strategic opportunities to collaborate, and to populate some of the information for the online research community networking directory.

MSI research faculty are recruited to participate in the residential training program at SDSC and Argonne National Lab. They are encouraged to attend the training event of most relevance to their research interests with expectation that they should embark upon a CI-related research project in collaboration with existing CI programs. The project team helps facilitate such collaborations as needed. Opportunities for interpersonal interaction are built into the training program to enable exchange of ideas and development of research collaborations some of which will enable informal, genuine mentoring of faculty and students. Informal short-term mentoring takes place in follow-up to the training program. In addition, MSI-CIEC continues to develop and foster partnerships with major research institutions, national laboratories, and federal agencies that support advanced technologies research and development.

3.3 VISITING FACULTY/STUDENT RESEARCH SYMPOSIA:

MSI-CIEC encourages Visiting Faculty/Student Research Symposia where potential research collaborators may be invited to visit a campus, MSI or majority institution, a national lab, CI resource or e-science research facility, or meeting of a distributed research group to exchange research ideas, explore possible research collaborations, make research plans and give an open talk to faculty and students about current or potential research.

3.4 RESEARCH PROPOSAL DEVELOPMENT:

Members of the CI Research Empowerment Team together with others recruited within the MSI-CIEC partnership identify and disseminate research funding opportunities and provide technical support for collaborative research proposal development for projects that involve MSI faculty in CI and e-science.

3.5 ALL HANDS MEETING:

Engagement of the current membership of the MSI-CIEC portfolio was undertaken in late January, 2010 at the San Diego Supercomputing Center during a two-day All Hands Meeting. The goals of this meeting were to: (1) have MSI-CIEC partners share their latest news and ideas regarding campus cyberinfrastructure development; (2) inform attendees about and make plans for upcoming workshops, CI Day events, and National Science Foundation proposals related to CI; and (3) collect feedback from partners who have already worked with MSI-CIEC on campus events, technology assessments, or infrastructure development about how we can improve the support and services MSI-CIEC provides. Twenty-one faculty members and IT experts from fourteen institutions and six MSI-CIEC representatives attended the event. Participant feedback, which was collected through an online survey in the week following the event, indicated strong interest among the MSI representatives in follow-up activities coordinated by the MSI-CIEC, including holding CI Day events at four campuses. A visit to the California Institute for Telecommunications and Technology, CalIT2, http://www.calit2.net/, demonstrated affordable technologies for interactive communication links, such as their Research Intelligence Portal and OptiPortal, and four MSI representatives expressed interest in installing smaller-scale versions at their own institutions. A low cost version ($20,000) provides a community building link for sharing of research, curriculum, tools etc. Interested participants will be engaged in a follow-up workshop in June sponsored by

CalIT2. Such Interactive Video Walls can also provide an institutional engagement in their local community and allow a growth of the research culture by bringing together faculty /students in a common project. Additional needs that were mentioned were low-cost student collaborative tools, campus support liaisons, taking faculty to CI related workshops, and applying jointly for additional funding. Feedback from the participants indicated that many were eager to begin working more concretely on proposals and collaborations with campuses that had similar or complementary goals, and they urged the MSI-CIEC to establish smaller, more-focused working groups and have regular conference calls among participants interested in particular projects.

4. SUMMARY OF PRELIMINARY RESULTS

Our findings identified a problem in identifying MSI faculty and institutions that "can be outreached/trained etc. Often the different NSF activities in this area all work with the same rather small group of people. We suggested proactive projects like CI-days as one approach to this issue. Another more speculative idea is to develop Web 2.0 style portals for community building and scientific discovery as it allows a broad range of people to participate with low barriers. Thus we are developing a MSI portal built with Web 2.0 to foster communities. Further we are working with Navajo Tech on use of Web 2.0 gadgets as an attractive technology for "easy to use" science gateways to TeraGrid aimed at education.

In addition there are very interesting developments in TeraGrid that have been facilitated by MSI CIEC. In 2008, several members of the GEON team and the TeraGrid Science Gateways Area Director travelled from SDSC to Navajo Tech to present a workshop for their faculty. They immediately saw how the GEON tools and applications could be useful for their research and education, and they plan to adopt them for their own purposes. GEON is one of the most successful Science Gateways, with links to the TeraGrid resources, though users don't need to use big iron to get value from the gateway tools and applications – most are web-based rather than HPC-dependent. This development has been the result of sustained efforts evolving from the partnership of Navajo Tech, MSI-CIEC, TeraGrid, and SDSC. The workshop was follow-on to participation by two Navajo Tech faculty in the GEON Summer Institute. GEON funded all their expenses and hopes to work with MSI CIEC in the future to recruit more minority scientists and graduate students to participate in their annual summer institute. Another Geon Summer Institute was held in the summer of 2009 at the SDSC.

MSI-CIEC has undertaken Campus Assessments at Elizabeth City State University, Navajo Technical College, New Mexico Highlands University, University of Houston Downtown, University of Texas Pan American and North Dakota's All-Tribes University. In addition we also undertook a CI Day event at these institutions and also at Howard University.

There are MSIs, either having some inroads into CI or projects that can be CI enabled, for whom MSI-CIEC can facilitate research and curriculum growth. California State University, San Bernardino, started a program in bioinformatics that the project could support and help incorporate CI in its research and education. University of Texas at Brownsville, a small campus in the UT system with impressive research gains in gravitational wave astronomy, participates in the Open Science Grid and offers a cost effective model for developing a campus for CI access. Bowie State University invested in a large scale system, and assistance can lead the campus sciences into CI activity, and provide regional CI resources. Southwest Indian Polytechnic Institute's work with University of New Mexico demonstrates how the collaboration of a two-year Tribal College and a four-year HSI helps both campuses become more active in CI and enhance the STEM education and transfer articulation. Howard and Florida International Universities, Universidad de Sagrado Corazon, Crownpoint Institute of Technology, Little Priest Tribal College, Our Lady of the Lake University and other MSIs have expressed interest.

MSI-CIEC is a partner in the new Homeland Security Center of Excellence at Purdue focused on Visual Analyticcs, http://www.purdue.edu/discoverypark/vaccine/. As such CI tools and resources play a crucial role. MSI-CIEC provides MSIs opportunities to participate in the collaborative research and training efforts of this

new Center which will bring our MSI students into the Security workforce.

Implementing National CI for MSI's - Suggested strategies and tactics, based on MSI-CIEC results:

- Fund local infrastructure and local infrastructure support
- Establish Tiger teams to visit MSIs and establish plans for institution CI-Enablement
- Identify a "simple" and "robust" CI-like software stack (could be an existing stack)
  - Identify for our MSIs pertinent and possible Security issues.
  - Explain role of Portals/Science Gateways versus "power user" access
- Define, Implement and Support an education and training model including "distance learning" (including "Access Grid" infrastructure) and institution curriculum integration
- Fund internships and other research opportunities (e.g. REU) for MSI faculty/students
- Provide MSI/Community CI Operations Center to provide support to MSI users of CI
- Empower Centers of Excellence to provide institutional support
- Research use of VM technology and shared desktops to allow remote hardware and remote support
- Involve "all organizations" (Internet2 to support network access; community organizations for scalability)
- Establish Partnerships between MSI's/ experienced National CI institutions for smooth CI-Enablement
- All aspects should be Systemic and aim at peer collaborations and not elite to non-elite relationships

ACKNOWLEDGEMENTS

The authors wish to acknowledge the leadership and hospitality of our colleagues at Navajo Tech, Elizabeth City State, New Mexico Highlands and Howard Universities, Universities of Houston Downtown, Texas Pan American, and New Mexico along with their respective campus colleagues.

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LONI (Louisiana Optical Network Initiative) http://www.loni.org/

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